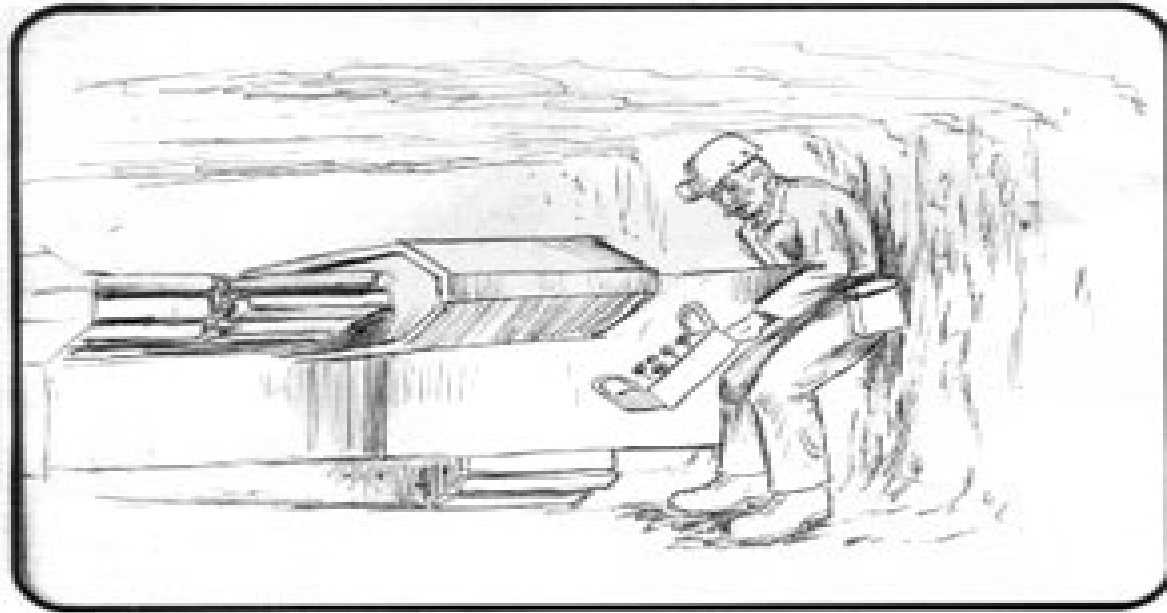


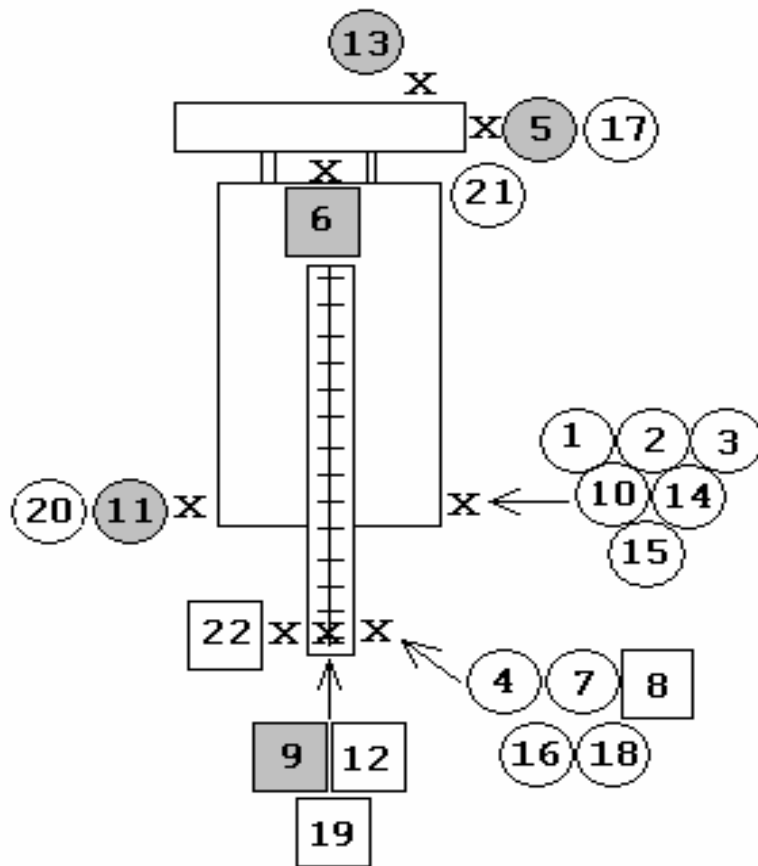
PROXIMITY PROTECTION

Improving Miner Safety



MSHA is currently working on a joint project with Massey Energy, Nautilus International and Joy Mining to develop a proximity protection system for installation on a continuous miner that will protect miners from crushing and pinning accidents when operating a remote controlled continuous miner.

Review of Remote Control Related Accidents



This is a depiction of a continuous miner that shows the relative location of each of the 22 fatal remote control related accident victims. The circles indicate that the victim was in possession of the remote control station. The gray indicates that the victim was performing a maintenance activity. The squares indicate the victim was not the operator.

Proximity Protection

- A safety system providing automatic proximity detection and machine shutdown when personnel are positioned in a hazardous area close to the machine

Project Partners & Commitments

- Nautilus provides permissible “Buddy” system
- Massey provides remote controlled continuous miner & mine site
- Joy provides assistance in designing system for machine mounting
- MSHA A&CC provides technical assistance and evaluation for MSHA approval

Before initiating the project, MSHA developed it's project partners. Massey Energy came to MSHA to request that we develop a proximity protection system. Nautilus had a mature system that was closest to field ready of the systems MSHA reviewed. Joy offered to provide the technical assistance necessary to design a system for continuous miner installation.

"Buddy" System Configuration

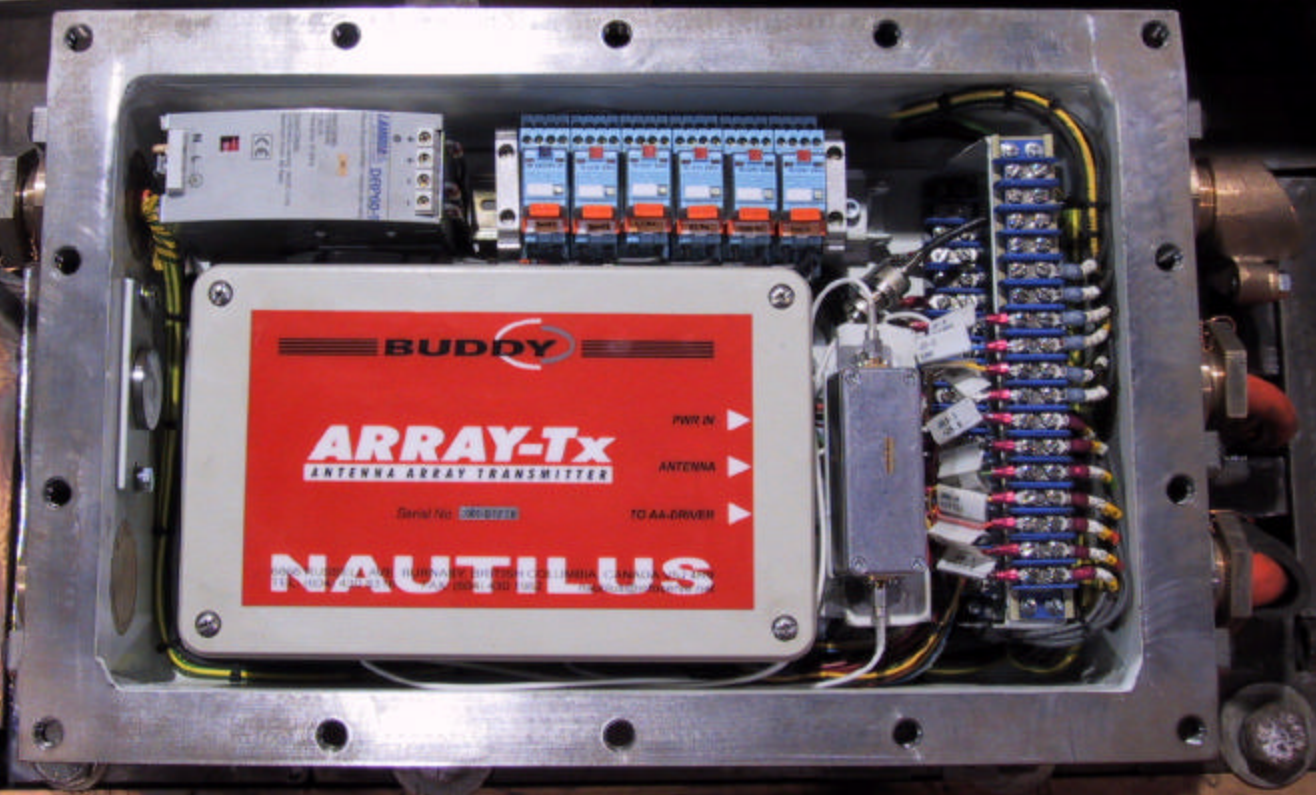
- Rechargeable, operator belt pack unit
- Machine electronics mounted in X/P enclosures
- Buddy Antenna housed in hose conduit to meet permissibility requirements
- Small 900 MHz data link antenna
- Machine flashing strobe light

The system consists of five primary components. (1) a belt pack unit worn by the machine operator; (2) on-board system electronics; (3) the magnetic field antenna; (4) a small data link antenna; and (5) a flashing strobe light. Pictures of the components follow.



Intrinsically Safe
Beltpack Unit

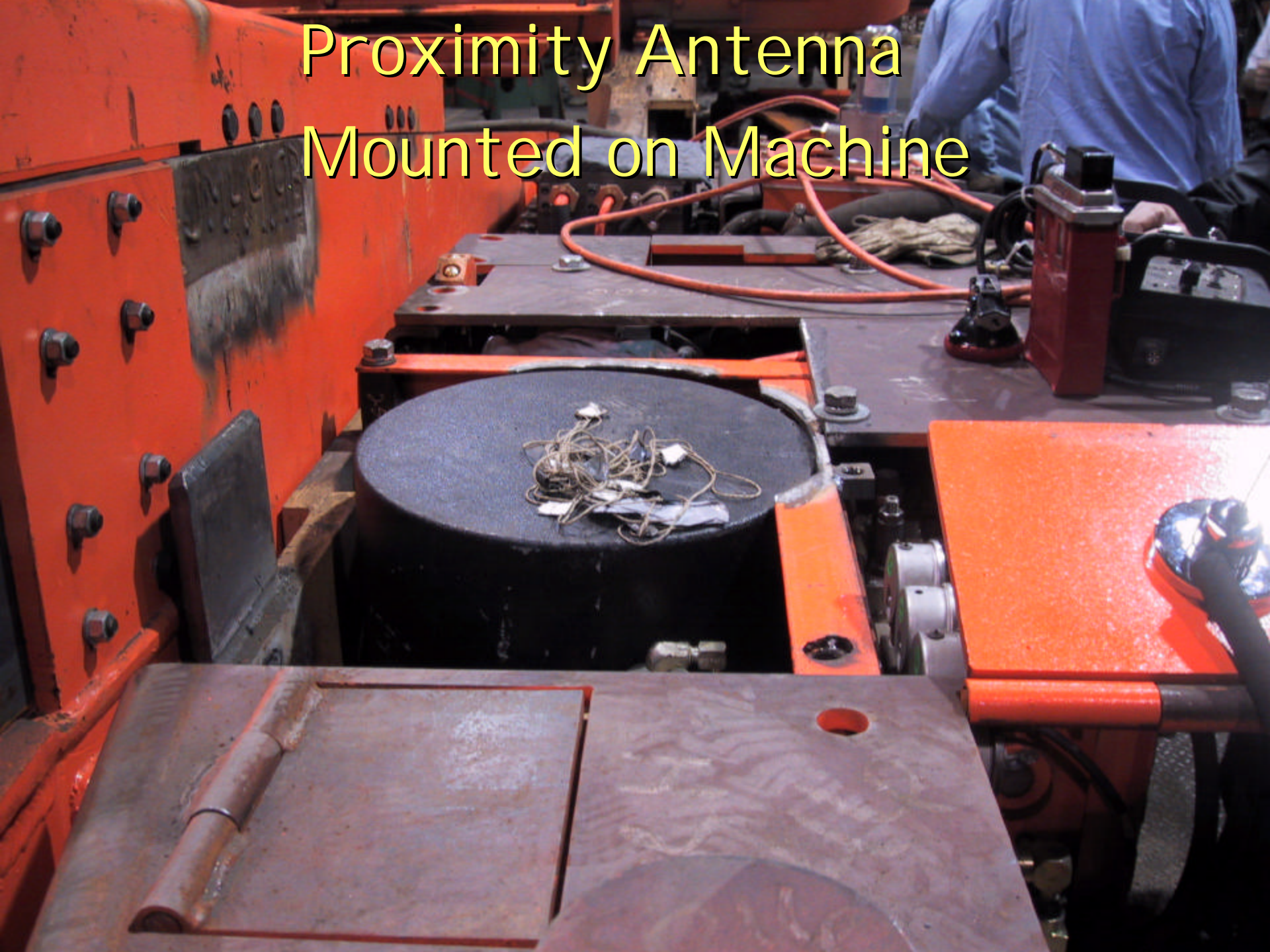
Machine Mounted Electronics



Antenna Cover Removed



Proximity Antenna Mounted on Machine



The image shows a close-up of industrial machinery. A large, orange-painted metal structure is visible. A small, cylindrical antenna is mounted on the side of this structure. Several black cables are bundled together and run across the scene. To the right, three pressure gauges are mounted on a panel, each with a white face and black markings. The gauges are connected to various hoses and fittings. The overall scene suggests a complex industrial or laboratory environment.

Intrinsically Safe 900 MHz
Data Signal Antenna

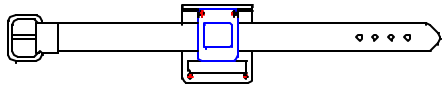
Machine Mounted Warning Strobe Light



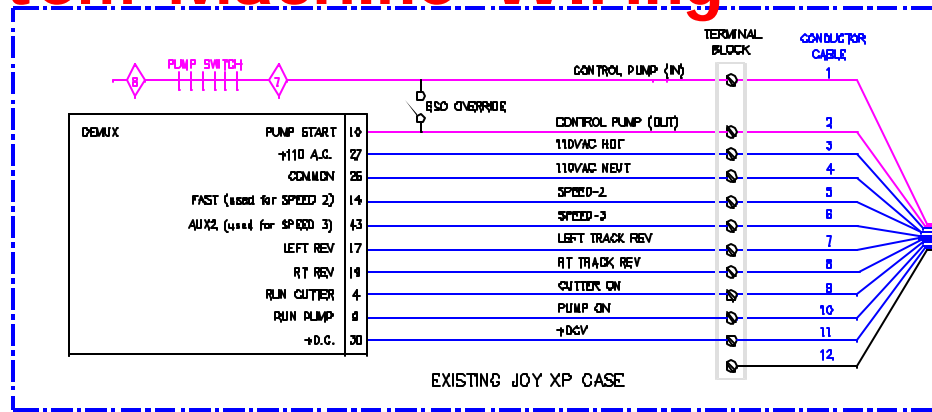
COMMONWEALTH OF
PENNSYLVANIA
APPROVAL NO. 11-11-11-11-11-11
MINING CONTROLS INC.
CERTIFIED TO COMPLY WITH
THE APPLICABLE REQUIREMENTS
OF 29 CFR 1926.106

Proximity System Machine Wiring

BELTPACK UNIT
CLASS-I DIV-II



JOY XP CASE

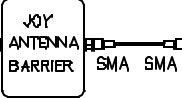


EXISTING JOY XP CASE

NAUTILUS ANTENNA

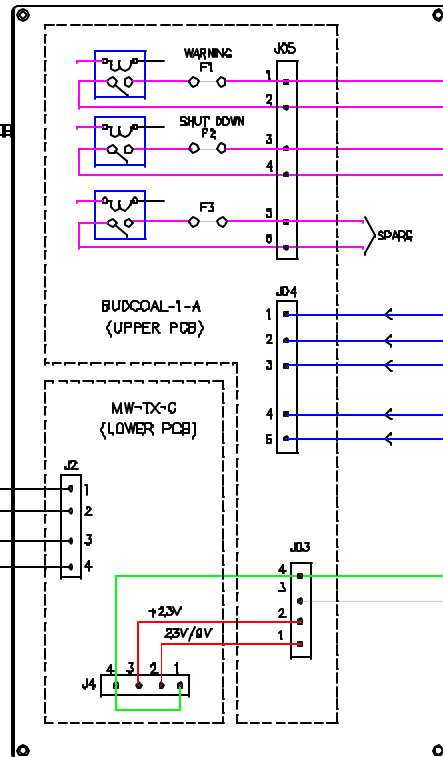
XP1

JOY XP CASE

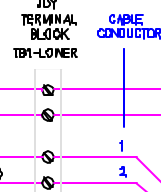


NAUTILUS ARRAY-TX

JOY ENCLOSURE MA001031-0020 X/P-4078-D

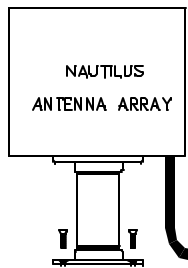


JOY TERMINAL BLOCK TRI-UPPER



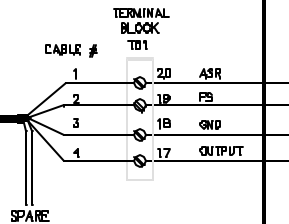
12

XP4



6

XP2



JOY 24V POWER SUPPLY

XP3



FLASHING LIGHT

JOY CONTINUOUS MINER

Theory of Operation

- Antenna generates low frequency, spherically shaped magnetic field
- Belt pack unit measures strength of magnetic field; calculates distances & transmits warning & machine shutdown commands

The on-board Buddy Antenna generates a magnetic field around the machine. The operator worn belt pack measures the strength of that magnetic field and can determine distances. The belt pack can then tell the machine to activate a warning signal or to shut down the machine.

System Performance Goals

- Separate programmable warning & shutdown distances for three machine tram speeds
- Protected by supervisor security codes
- Distance changes automatically when machine speed is changed
- Provisions for visible & audible machine alarms

Before initiating the field test, the project partners decided on some basic system parameters. We wanted the system to be capable of providing warning and shutdown commands at all available machine speeds. We wanted security in the system to prevent unauthorized programming changes. We wanted the warning and shutdown distances to change when tram speed changed, and we wanted the system to be able to activate both visual and audible machine alarms.

Project Challenges

- Design belt pack unit to be I S
- Design machine electronics for XP enclosure mounting
- Design low profile permissible antenna
- Design mechanical protection for the antenna

During the system development, there were many challenges faced by the project partners. The main hurdles we faced were designing the belt pack to be intrinsically safe (permissible); designing the on-board electronics for mounting in an explosion-proof enclosure; designing the antenna for convenient mounting on a continuous miner; and developing sufficient mechanical protection for the antenna.

Field Test Parameters

- Proximity Protection System Installed on Joy 12CM Miner
- Protect right rear quadrant of machine
- Proximity protection disabled when cutter head is on

For the purposes of the field trial, some initial decisions were made. The system was designed for installation on a Joy 12CM since that was the machine that Massey had available. Because the heavy concentration of accidents was around the right rear quadrant of the machine, we decided that the field trial would focus on protection of that area of the machine. We also wanted proximity protection deactivated during cutting operations to avoid nuisance shutdowns and because no fatalities had occurred when in the cutting mode.

Shutdown & Warning Distance Settings for Field Trial

- Speed 1 Shutdown Distance – 3.9 Feet
- Speed 2 Shutdown Distance – 12.0 Feet
- Speed 3 Shutdown Distance – 13.8 Feet
- Warning Distance – Add 3 Feet to Shutdown Distance
- Distance Boom Tip to Rear Edge of Machine – 10.5 Feet

These warning and shutdown distances were selected based on discussions with the project partners and factory testing observations.

Installation, Test, and Demonstration Timeline

- **"Buddy" System installed and tested at Joy's Duffield, VA Service Center April 24**
- **Industry demo on June 3**
- **Field trial began on July 14**
- **Field trial suspended on July 17**

The system was originally installed and tested at Joy's Duffield VA Service Center in April 2003. After resolving several identified problems, the system was demonstrated to industry personnel at Massey's Sidney Coal Shop in June 2003. The field trial began at Massey's Rockhouse Energy Mine on July 14, 2003 and suspended on July 17, 2003.

Field Trial

- **Field test intended to be conducted for a 4 week period**
- **A&CC personnel monitored the system**
 - **Pre and post shift calibration checks of warning and shutdown distances**
 - **Document system operational or performance problems**

The field test, which started on July 14, 2003, was intended to take place over a four week period. Approval and Certification Center people were on site to monitor the system performance and document problems encountered. The field test was suspended after three days due to the significant problems encountered.

Field Test Results

- One belt pack unit malfunctioned; second unit had short battery life
- Gradual system calibration drift forced operator to unacceptable distances from machine

The two primary problems encountered were the malfunctioning of the belt pack units. They were found to have deteriorated battery life. It was also found that the programmed warning and shutdown distances drifted during the working shift which forced the operator to stand further and further from the machine.

Field Test Observations

- Machine mounted components survived
- Mechanical protection needed for belt pack
- Presence of shuttle car increases system sensitivity somewhat directly behind machine
- “Buried” Buddy antenna results in inadequate system range

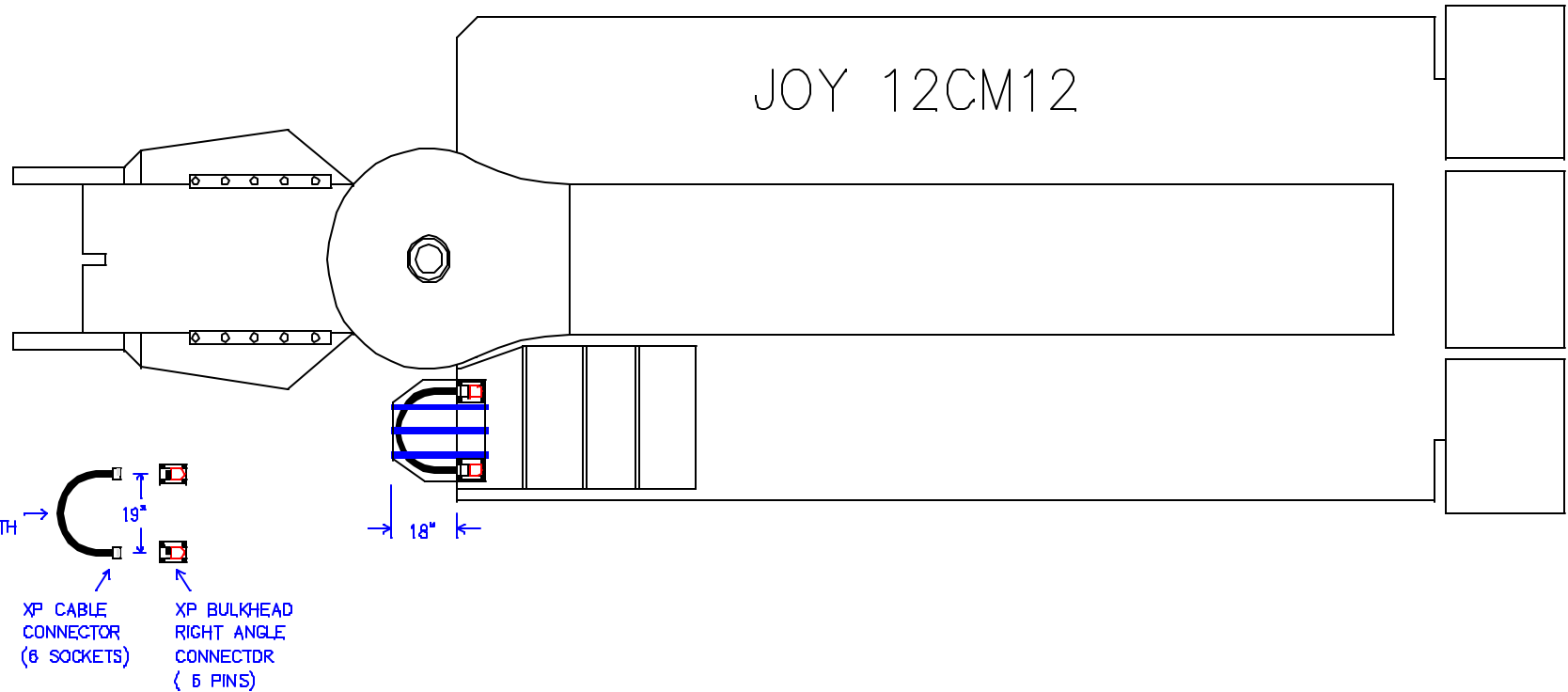
Significant field test findings: Although the field trial only lasted three days, the machine mounted components had been installed on the operating machine for a month and had survived that period. We learned that mechanical protection is needed for the belt pack. We also observed that the presence of the shuttle car caused increased sensitivity of the system directly behind the machine. We learned that the antenna being buried in the machine frame resulted in insufficient system range.

Corrective Actions

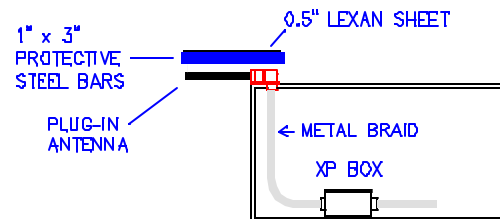
- **Charger circuit in beltpack unit modified**
- **New antenna design to provide increased range and eliminate calibration drift**

Several significant design changes have been implemented to address the problems identified in the field test. The charger circuit in the belt pack unit was modified to eliminate the battery life problem. The magnetic field antenna was completely re-designed to increase the system range and eliminate the calibration drift problem.

PLAN VIEW



ELEVATION



This is a sketch of the modified antenna configuration.

New Antenna design



Resumption of Field Trial

- Basic technology and system performance shows promise
- Above-ground testing will be conducted at Joy in Franklin, PA to evaluate antenna and system design changes in March 2004
- Underground Field Testing to resume in June 2004

Although the original field test only lasted for 3 days, the project partners were greatly encouraged at the potential the system has to improve the safety of remote controlled continuous miner operations. Factory testing of the revised system is anticipated in March 2004 at Joy's Franklin, PA facility with the resumption of the field test to occur shortly after.